

ABSTRACT OF THE DISCLOSURE

New Group III based diodes are disclosed having a low on state voltage (V_f) and structures to keep reverse current (I_{rev}) relatively low. One embodiment of the invention is Schottky barrier diode made from the GaN material system in which the Fermi level (or surface potential) of is not pinned. The barrier potential at the metal-to-semiconductor junction varies depending on the type of metal used and using particular metals lowers the diode's Schottky barrier potential and results in a V_f in the range of 0.1-0.3V. In another embodiment a trench structure is formed on the Schottky diodes semiconductor material to reduce reverse leakage current. and comprises a number of parallel, equally spaced trenches with mesa regions between adjacent trenches. A third embodiment of the invention provides a GaN tunnel diode with a low V_f resulting from the tunneling of electrons through the barrier potential, instead of over it. This embodiment can also have a trench structure to reduce reverse leakage current.